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IS 15406-1 (2003): Capacitors for Microwave Ovens - Part : 1 General [ETD 29: Power Capacitors]

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भारतीय मानक

माइक्रोवेव ओवनों के लिए संधारित्र

भाग 1 सामान्य

Indian Standard

CAPACITORS FOR MICROWAVE OVENS

PART 1 GENERAL

ICS 31.060.70;97.040.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

October 2003

Price Group 8

NATIONAL FOREWORD

This Indian Standard (Part 1) which is identical with IEC 61270-1(1996) 'Capacitors for microwave ovens — Part 1 General' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendations of the Power Capacitor Sectional Committee and approval of the Electrotechnical Division Council.

The text of the IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

CROSS REFERENCES

In this adopted standard, references appear to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60068-1(1988) Environmental testing — Part 1 : General and guidance	IS 9000 (Part 1): 1988 Basic environmental testing procedures for electronic and electrical items: Part 1 General (*first revision*)	Technically equivalent
IEC 60068-2-1(1990) Environmental testing — Part 2: Tests — Tests A: Cold	IS 9000 (Part 2/Sec 1 to 4) : 1977 Basic environmental testing procedures for electronic and electrical items: Part 2 Cold test (Sections 1 to 4 in one volume)	do
IEC 60068-2-3(1969) Environmental testing — Part 2: Tests — Tests Ca: Damp heat, steady state	IS 9000 (Part4): 1979 Basic environmental testing procedures for electronic and electrical items: Part 4 Damp heat (steady state)	do
IEC 60068-2-14 (1984) Environmental testing — Part 2: Tests — Test N: Change of temperature	IS 9000 (Part 14/Sec 1 to 3): 1988 Basic environmental testing procedures for electronic and electrical items: Part 14 Test N : Change of temperature (Sections 1 to 3 in one volume) (*first revision*)	do
IEC 60068-2-20 (1979) Environmental testing — Part 2: Tests — Test T:Soldering	IS 9000 (Part 18/Sec 1 to 3): 1981 Basic environmental testing procedures for electronic and electrical items: Part 18 solderability test (Sections 1 to 3 in one volume)	do

(*Continued on third cover*)

Indian Standard
CAPACITORS FOR MICROWAVE OVENS
PART 1 GENERAL

1 General

1.1 *Scope and object*

This part of IEC 1270 applies to capacitors for microwave ovens operating at rated a.c. voltages of up to 3 000 V and a superimposed d.c. voltage of up to $0{,}8 \cdot \sqrt{2}$ times the value of rated a.c. voltage.

This standard relates specifically to capacitors with a metal case and an upper rated maximum temperature of up to 100 °C, non-self-healing, with metal foil electrodes and dielectrics of paper and/or plastic, impregnated with a suitable oil.

The object of this standard is:

a) to formulate uniform rules regarding performance, testing and rating;

b) to formulate specific safety rules.

1.2 *Normative references*

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 1270. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 1270 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 68-1: 1988, *Environmental testing – Part 1: General and guidance*

IEC 68-2, *Environmental testing – Part 2: Tests*

IEC 68-2-1: 1990, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 68-2-3: 1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 68-2-14: 1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

IEC 68-2-20: 1979, *Environmental testing – Part 2: Tests – Test T: Soldering*

IEC 68-2-21: 1983, *Environmental testing – Part 2: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 112: 1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

IEC 335-2-25: 1993, *Safety of household and similar electric appliances – Part 2: Particular requirements for microwave ovens*

2 Definitions

For the purposes of this part of IEC 1270, the following definitions apply.

2.1 **capacitor for microwave ovens:** Power capacitor which is connected in the main power supply circuit of the magnetron of a microwave oven operated from a 50 Hz or 60 Hz power line, the capacitor being a component of the circuit for stabilizing the magnetron current.

2.2 **capacitor element:** Device which consists of two electrodes separated by a dielectric. The capacitor is constructed by assembling together one or more capacitor elements inside the same case and connecting the electrodes to external terminals.

2.3 **rated voltage (U_N):** The r.m.s. value of the alternating voltage for which the capacitor has been designed. A superimposed d.c. voltage of up to $0{,}8.\sqrt{2}$ times the value of the rated a.c. voltage is permitted.

2.4 **highest rated voltage (U_m):** Highest r.m.s. value of the alternating voltage(s) at which the capacitor has been designed to operate: it can be of interest particularly when two or more capacitors are structurally combined together inside the same case. Then U_m is the highest rated voltage of the combined capacitors.

U_m is used as the reference for measuring the insulation between the terminals and the case.

Unless otherwise specified, $U_m = U_N$, but in any case $U_m \geq U_N$. Any difference between the highest rated voltage (U_m) and the rated voltage (U_N) should be indicated on the capacitor.

2.5 **minimum permissible capacitor operating temperature:** Minimum permissible temperature on the outside of the case at the moment of switching on the capacitor.

2.6 **maximum permissible operating temperature (t_c):** Maximum permissible operating temperature of the hottest area of the outside of the capacitor case during operation.

2.7 **rated frequency (f_N):** Highest mains frequency for which the capacitor has been designed to operate, i.e. 50 Hz or 60 Hz.

2.8 **rated capacitance of the capacitor (C_N):** Capacitance value for which the capacitor has been designed.

2.9 **rated current (I_N):** The r.m.s. value of the alternating current at the rated voltage and frequency.

2.10 **type of capacitor:** Capacitors are considered to be of the same type when of similar constructional form, the same constructional technology, the same rated voltage, the same climatic category and the same kind of operation. Capacitors of the same type can differ only in rated capacitance and size. Minor differences between terminations and mounting devices are permitted.

2.11 **model of capacitor:** Capacitors are considered to be of the same model when they are of the same construction and have the same functional and dimensional characteristics within the tolerance limits and are consequently interchangeable.

2.12 **application class of capacitor:** Two application classes of capacitors are considered:

- standard class: capacitors for standard applications (household microwave ovens);
- professional class: capacitors for commercial microwave ovens (microwave ovens for communities, refectories, canteens, hospitals, restaurants, etc.).

3 Service conditions

This standard gives the requirements for capacitors intended for use under the following conditions:

3.1 *Altitude*

Not exceeding 2 000 m.

3.2 *Pollution*

Capacitors included in the scope of this standard are designed for operation in lightly polluted atmospheres.

NOTE – The IEC has not yet established a definition for "lightly polluted". When this definition is established, it will be incorporated in this standard.

3.3 *Operating temperature*

Between –10 °C and +100 °C (see 2.5 and 2.6). The preferred minimum and maximum permissible capacitor operating temperatures are as follows:

- minimum temperature: –10 °C;
- maximum temperatures: +60 °C; +70 °C; +85 °C; +100 °C.

Capacitors shall be suitable for transport and storage at temperatures down to –25 °C, without adverse effect on their quality.

3.4 *Damp heat severity*

The preferred severity is 21 days, according to IEC 68-2-3.

No lower severity is allowed.

4 Safety and construction

4.1 *Safety*

4.1.1 Capacitors shall be constructed in such a way that no external damage is caused in normal conditions of transport.

4.1.2 Where the individual capacitor elements are protected by fuses, these fuses shall be so dimensioned and so arranged within the circuitry of the capacitor unit that they will not disconnect in the event of a short circuit occurring outside the capacitor unit when it is being operated at the rated voltages. The appropriate fuse shall, however, operate in the event of the breakdown of one of the capacitor elements.

4.1.3 Resistors or diodes inside the capacitor case shall not reduce substantially the operational reliability of the capacitor, for instance due to the breakdown of the resistor or as a result of the action of chemical substances. In any case these components shall meet the relevant IEC standards.

4.1.4 Discharge resistors structurally combined with capacitors shall be so dimensioned that the voltage at the capacitor's terminals,1 min after the operating voltage is switched off, shall have fallen to below 50 V. They shall also withstand the voltage test in accordance with 5.9. The effect of the superimposed d.c. voltage shall also be taken into account in the dimensioning of discharge resistors.

4.1.5 Capacitors for microwave ovens generally do not contain internal fuses. In case of internal breakdown, normally a low-resistance short circuit will result. In case of short circuit of the capacitor, if the fuse of the appliance is able to disconnect the electric circuit within 3 s, case rupture or fire will be avoided.

The incorporation of such a fuse shall be in accordance with IEC 335-2-25.

4.2 *Terminations*

4.2.1 The terminations (screw, soldering, tag terminations) shall be so positioned that the capacitor, when correctly connected, will not be subjected to damage, short circuit or interruptions.

4.2.2 The mechanical resistance of the terminations shall be sufficient to prevent any risk of damage during assembling or operation, especially in case of a short circuit.

4.2.3 Terminals shall be correctly designed with reference to the necessary cross-section of the connecting conductors.

4.2.4 *Safety*

Capacitors shall be installed in such a way so as to protect the terminations against casual contacts.

When the capacitor has no suitable protection on the terminals, the case as well shall be protected against casual contacts.

4.3 *Creepage distances and clearances*

The creepage distances over external surface of terminal insulation and the clearances between the exterior parts of terminal connections or between such live parts and the metal case of the capacitor shall be not less than the minimum values given in table 1.

These minimum distances shall apply to the terminals with or without the external wiring connected. They are not intended to apply to internal creepage distances and clearances.

The requirements for specific applications shall be satisfied.

The contribution of any groove less than 1 mm wide shall be limited to its width.

Any air-gap of less than 1 mm shall be ignored in calculating the total air path. Creepage distances are distances in air, measured along the external surface of insulating material. These shall be calculated using *a* and *b* values given in table 1, according to the resistance to surface currents of the material (Comparative tracking index, CTI), as indicated in table 2.

Table 1 – Minimum creepage distances and clearances

Upper limit of the rated voltage		Distances in		
		air	surface	
Alternative current (r.m.s.) V	Direct current V	mm	*a* mm	*b* mm
500	600	3	4	5,5
660	800	4	5,5	7
750	900	4,5	6	8
1000	1200	6	8	11
1500	1800	9	12	17
2000	2400	12	16	23
2500	3000	15	20	30
3000	3600	18	25	36
6000	7200	36	50	70

Table 2 – Surface distances as a function of insulating materials

Comparative tracking index [1] V	Surface distances with ribs	Surface distances without ribs
CTI > 100	*b*	(*a* + *b*) / 2
CTI = 380	(*a* + *b*) / 2	*a*
CTI > 600	*a*	*a*

[1] The CTI of the material is determined according to IEC 112, using solution A.

4.4 *Temperature dependence of the capacitance*

The actual value of the capacitance of the capacitor, when stored for at least 3 h in the absence of voltage at the upper and lower temperature limits, may deviate from the actual value at 20 °C by not more than the amounts indicated in table 3 for each group. This shall be indicated by the manufacturer.

Table 3 – Maximum capacitance deviations at the temperature limits

Upper and lower temperature limit °C	Capacitor temperature °C			Groups of maximum capacitance deviation a %	b %	c %
+100	+20	up to	+100	+6	–5	+1,5
+85	+20		+85	+5,5	–5,5	+1,5
+70	+20		+70	+4,5	–4	+1
+60	+20		+60	+3,5	–3,5	+0,5
0	0		+20	–2	+1	+0,5 / –3
–10	–10		+20	–3	+3,5	+0,5 / –3

NOTE – The groups of table 3 correspond to the physical characteristics of common dielectrics. A linear interpolation between adjacent values of *a*, *b*, *c* columns is allowed in case of limit temperatures which differ from those indicated.

4.5 *Capacitance tolerance*

The capacitance tolerance is determined by the application. The preferred tolerance is ±4 %.

Coloured dots or other methods to identify narrower tolerance ranges inside the rated tolerance limits are acceptable. These indications shall be agreed between user and manufacturer.

4.6 *Voltage*

When specifying the rated voltage (U_N) and the highest rated voltage (U_m) of a capacitor, account shall be taken of the operating voltage at the terminals for a long period under the least favourable operating conditions.

NOTE – The conditions resulting from the application of the tests of the microwave oven according to IEC 335-2-25 should be considered. However, only the conditions which may last for at least one full operation period of the oven should be taken into consideration.

4.7 *Load capacity*

The capacitor shall be capable of being loaded as follows at its standard continuous service rating, at case temperatures up to t_c:

a) with an a.c. voltage of 1,1 times the rated voltage (U_N);

b) with an a.c. current of 1,3 times the current which flows through the capacitor at the rated voltage and rated frequency. Due to the effect of harmonics, the capacitor shall be able to be loaded for a short period of time with higher values of current. Duration and current value shall be agreed between user and manufacturer;

c) with a superimposed d.c. voltage of up to $0{,}88 \cdot \sqrt{2}$ times the rated a.c. voltage.

4.8 *Marking*

The following information shall be marked on the capacitor:

a) manufacturer's name, abbreviated name or trade mark;
b) manufacturer's type designation;
c) rated capacitance (C_{N}), in microfarads (µF), and tolerance as a percentage;
d) rated voltage (U_{N}) and, if necessary, rated superimposed d.c. voltage, in volts;
e) class of application: S, if standard class; P, if professional class (see 2.12);
f) climatic category, e.g. 10/85/21 (clause 3);
g) rated frequency f_{N}, in hertz;
h) discharge resistor, if any, with the symbol ─▭─ ;
i) wiring diagram, if necessary;
j) highest rated voltage (U_{m}), if greater than U_{N};
k) date of manufacture (a code may be used);
l) approval mark(s) with reference to this standard's number;
m) an abbreviated designation of the impregnation medium. The "NO PCB" wording is allowed.

5 Tests

5.1 *General*

5.1.1 *Non-destructive testing*

The test is non-destructive if the capacitor tested is not damaged, neither mechanically nor electrically. This test does not reduce the useful life of the capacitor.

5.1.2 *Destructive testing*

The test is destructive if the capacitor may be damaged by the test, electrically or mechanically, or may be unsuitable for further use after the test, which may shorten its useful life.

5.2 *Test conditions*

Unless otherwise specified for a particular test or measurement, the temperature of the capacitor dielectric shall be in the range +15 °C to +35 °C and shall be recorded.

If corrections are necessary, the reference temperature shall be +20 °C.

NOTE – It may be assumed that the dielectric temperature is the same as the ambient temperature, provided that the capacitor has been left in an unenergized state at this ambient temperature for an adequate period, depending on the size of the capacitor.

5.3 *Nature of tests*

The tests specified are:

- a) type tests;
- b) routine tests.

5.3.1 *Type tests*

Type tests are intended to prove the soundness of the design of the capacitor and its suitability for operation under the conditions detailed in this standard.

Type tests shall have been carried out by the manufacturer and/or the test authority if there is the need for an approval.

Type tests may be carried out under the supervision of a proper authority which will issue a certified record and/or type approval.

5.3.2 *Routine tests*

Routine tests shall be carried out by the manufacturer on every capacitor before delivery.

If the purchaser so requests, he shall be supplied with a certificate stating that the routine tests have been carried out.

5.4 *Type tests*

5.4.1 *Test procedure*

The samples of each model selected for the type tests shall be divided in three groups, as indicated in table 4.

Capacitors forming the sample shall have successfully passed the routine tests indicated in 5.5.1.

Each test group shall contain, as near as possible, an equal number of capacitors of the highest and the lowest capacitance in the range.

5.4.2 *Extent of qualification*

A type test on a sample consisting of a single model qualifies only the model tested. When the type test is performed on two models of the same type, and of different rated capacitance value, selected under the rules of 5.4.1, the qualification is valid for all other models of the same type having rated capacitance between the two tested values.

The qualification tests carried out successfully on a capacitor model having a certain capacitance tolerance are valid also for capacitors of the same model but having different capacitance tolerances.

Occasionally, capacitors are requested with a capacitance tolerance that is not symmetrical with respect to the rated capacitance value.

When a type test is carried out successfully on a capacitor model having a symmetrical capacitance tolerance, the relevant qualification is valid also for capacitors of the same model having a non-symmetrical capacitance tolerance provided that the total range of non-symmetrical tolerance is less than or equal to that of the tested capacitor model.

5.4.3 *Tests on capacitors with a number of ratings*

When a capacitor is designed to operate under two or more different conditions (rated voltages, temperatures, application class, etc.), it shall satisfy all the conditions of testing which correspond to the marking.

Voltage tests shall be carried out at the highest test voltage only, when voltage is the only different parameter.

5.4.4 *Type tests schedule*

Table 4 – Type tests schedule

Group	Tests [1] [2] [3]	Clause	Number of samples to be inspected	Number of failures allowed in first test	Number of failures allowed in retest
1	Visual examination	5.6	10	1	0
	Check of markings	4.8			
	Check of construction	4.1, 4.2 and 4.3			
	Capacitance measurement	5.7			
	Temperature dependance of the capacitance	4.4			
	Voltage test between the terminals	5.9			
	Voltage test between the terminals and the case	5.10			
	Voltage test between elements (if applicable)	5.11			
	Capacitance measurement	5.7			
	Mechanical and climatic tests	5.14 and table 6			
2	Climatic tests	5.14 and table 7	10	1	0
3	Endurance test	5.13	10	1	0

[1] Test results are positive with zero failure; a retest is allowed with one failure. With two or more failures, a new sampling is necessary for all type tests.

[2] Tests listed are non-destructive, except tests of 5.13 and 5.14.

[3] A capacitor which fails in more than one test is counted as one defective capacitor.

When the number of defectives for each group does not exceed the figures indicated in table 4, the capacitor model is deemed to comply with the standard.

The endurance test shall be performed for every voltage, application class and temperature rating marked on the capacitor. The number of samples to be inspected shall be calculated accordingly.

5.5 *Routine tests*

5.5.1 *Test procedure*

Capacitors shall be subjected to the following tests in the stated order:

a) voltage test between the terminals (see 5.9);

b) voltage test between terminals and case (see 5.10);

c) visual examination (see 5.6);

d) capacitance measurement (see 5.7);

e) test of the internal discharge device, if applicable (see 5.12).

5.6 *Visual examination*

The condition, workmanship, marking and finish shall be satisfactory. The marking shall be legible throughout the life of the capacitor.

5.7 *Capacitance measurement*

5.7.1 The capacitance shall be measured using a method which excludes errors due to harmonics.

5.7.2 Capacitance shall be measured at the rated frequency and at a voltage of an r.m.s. value of at least 500 V. Different voltages and frequencies may be used, provided that a correlation factor has been determined and is applied to the test limits.

5.7.3 The measuring error shall not exceed 10 % of the tolerance range of the capacitor, plus 0,1 % of the measured value.

5.8 *Voltage tests*

5.8.1 *General*

Test conditions: see 5.2.

During the tests no breakdown or flashover shall occur.

5.8.2 *Test procedure*

The d.c. voltage test shall be conducted using the circuit of figure 1.

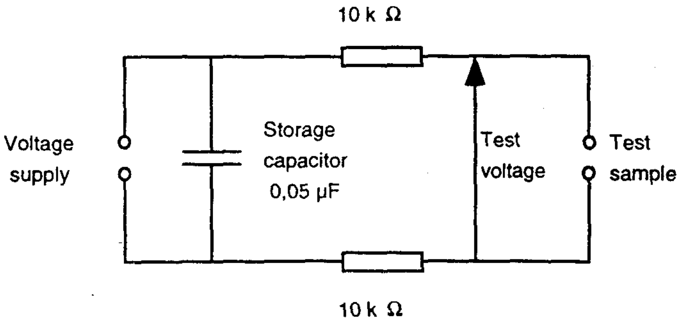

Figure 1 – Electric circuit for d.c. voltage test

The r.m.s. value of the superimposed a.c. voltage should not exceed more than 6 % the test voltage during the test and its peak value should not exceed more than 9 % the test voltage.

Where voltage sources have high internal resistance, a storage capacitor shall be connected in parallel to the voltage source. The internal resistance of the voltage source and the capacitance of the storage capacitor shall be matched to one another in such a way that the charging time constant of the test sample does not exceed 3 % of the test duration.

In the case of a.c. voltage tests, the test voltage shall be of a sinusoidal waveform and the frequency shall be $0,8\ f_N \leq f \leq 1,2\ f_N$.

5.9 *Voltage test between the terminals*

Capacitors shall be tested according to table 5.

The test voltage shall be increased to its full value starting from half the test voltage value. The duration of the test shall be calculated from the moment at which the full value has been reached.

In order to reduce the risk of arcing when switching off the capacitor under test, it is recommended to connect a resistor in series to the capacitor or to reduce the voltage by de-energizing the voltage generator.

Table 5 – Test voltages and durations

Tests	Nature of test voltage [1]	Ratio of test voltage to U_N	Test duration s
Routine tests [2]	d.c.	4,3	10
	a.c.	2,15	10
Type tests	d.c.	4,3	60
	a.c.	-	-

[1] The choice is left to the manufacturer.

[2] The duration of the test can be reduced to 2 s if the test voltage is increased to 1,1 times the indicated value.

5.10 *Voltage test between terminals and case*

The test shall be performed between the terminals joined together and the case at an a.c. voltage at a frequency of 50 Hz or 60 Hz. The full value of the voltage shall be applied.

Test voltages and durations shall be as follows:

- routine tests: 2,4 U_m + 1200 V, but at least 6 kV, for 1 s;
- type tests: 2,0 U_m + 1000 V, but at least 5 kV, for 60 s.

If two or more capacitors are structurally combined together, i.e. inside the same case, the test voltage shall be calculated with reference to the highest rated voltage of the combined capacitors.

5.11 *Voltage test between capacitor elements*

Test voltages and durations indicated in table 5 are also applicable to the insulation layers between two capacitor elements which are structurally combined together.

The electrodes of each individual capacitor element shall be connected together. The test voltage shall be applied between the capacitor elements.

Should the capacitors have an internal diode, they shall be tested between the terminals and the case with a d.c. voltage of the same value as the peak value of the a.c. test voltage as per table 5.

For this test, the voltage polarity shall be in the non-conducting direction of the diode.

5.12 *Test of internal discharge device*

The resistance of the internal discharge device, if any, shall be checked either by a resistance measurement or by measuring the self-discharge rate (see 4.1.4). The choice of the method is left to the manufacturer.

The test shall be made after the voltage test between the terminals (see 5.9).

5.13 *Endurance test*

5.13.1 *Test conditions*

The endurance test shall be carried out at the maximum permissible operating temperature t_c. This test is a destructive test.

Number of samples to be tested	10
Test temperature of the capacitors	$t_c \pm 2$ °C
a) Standard class (see 2.12):	
Test voltage	1,25 $U_N \pm 5$ %
Duration	500 h

b) Professional class (see 2.12):

Test voltage	1,35 U_N ± 5 %
Duration	750 h

The samples shall be selected by the manufacturer in such a way that their power dissipation under test conditions lies at the upper limit of scatter for the model concerned.

On completion of the endurance test, a voltage test between the terminals and the case (see 5.10) shall be carried out.

5.13.2 *Conditions of compliance*

At the end of the test a capacitor shall be considered as failing if:

- it is interrupted;
- it is in short circuit to the case;
- its capacitance is changed more than 3 % with reference to the initial measurement;
- droplets of leaking internal liquid material are visible.

The test is considered successful if:

- after 10 min at t_c in the less favourable position (usually upside down, terminals at the bottom), there is no oil leakage;
- capacitance change measured before and after the endurance test is within the specified limit, after the capacitors have reached ambient temperature. In case of doubt, the final measurement shall be carried out at the same temperature as the initial measurements.

At the end of the test and before the final measurements, the capacitors shall be discharged through the built-in discharge resistor, if any, or through an external suitable means.

5.14 *Mechanical and climatic tests*

5.14.1 *General*

These tests shall be carried out in conformity with the relevant test in IEC 68-2.

Each test consists of preliminary conditioning, initial measurements, stressing, final conditioning and final measurements. The test sequence is indicated in tables 6 and 7.

The description of the environment and of the preliminary and final conditioning are contained in IEC 68-1. The relevant sections of IEC 68-1 are listed in tables 6 and 7.

Initial and final measurements shall be carried on in a test room in accordance with IEC 68-1.

5.14.2 *Test procedure*

Test group 1: table 6.

For the purposes of test Ud, a torque of 4 N.m shall be applied for a thread diameter of 8 mm, and a torque of 7 N.m for a thread diameter of 12 mm.

Test group 2: table 7.

5.14.3 *Sealing test*

Capacitors with filling material that is liquid at less than t_c + 5 °C shall be heated to a temperature of t_c + 5 °C, mounted in a position most likely to reveal leakage.

Capacitors shall be maintained at this temperature for sufficient time for all internal parts of each capacitor to reach this temperature.

Capacitors shall be maintained at this temperature for a further hour before cooling.

After the sealing test, capacitors shall be inspected for liquid leakage: no leakage shall occur.

6 Environmental protection

Capacitors may contain polluting and flammable materials. They shall thus be considered as potentially dangerous for the environment.

For this reason care shall be taken in their use, in order to avoid any possible risk to people and objects.

The use of PCB is forbidden.

Table 6 – Test group 1: mechanical and climatic tests

Tests and measurements	Standard	Test	Test method and requirements
Tensile (connecting leads and solder terminals)	IEC 68-2-21	Ua 1	On all terminals connected together, with a force twice the weight of the capacitor, but at least 20 N; or individually on each terminal, with at least 10 N
Bending (wire terminations)	IEC 68-2-21	Ub	Number of bends: 2 Method: 2
Bending (tag terminations)	IEC 68-2-21	Ub	Number of bends: 2 Method: 2
Torsion (wire terminations)	IEC 68-2-21	Uc	Severity grade: 1
Torque (screw terminals)	IEC 68-2-21	Ud	See 5.14.2
Solderability and resistance to solder heat	IEC 68-2-20	Tb	Bath method at 350 °C; Method 1B
Cold	IEC 68-2-1	Aa	Test temperature: minimum permissible temperature, but not higher than –25 °C; duration 16 h
Preliminary conditioning for measurements	IEC 68-1		Duration: 3 h Standard atmospheric conditions
Initial measurements	IEC 68-1		Test conditions: see 5.2 Voltage test between the terminals: see 5.9, table 5 Voltage test between the terminals and the case: see 5.10 Capacitance measurement: see 5.7
Rapid changes of temperature	IEC 68-2-14	Na (two-room method)	Duration: 3 h Standard atmospheric conditions Between minimum and maximum permissible temperatures
Final conditioning before measurements	IEC 68-1		Duration: 3 h Standard atmospheric conditions
Final measurements	IEC 68-1		Test conditions: see 5.2 Voltage test between the terminals: see 5.9, table 5 Voltage test between the terminals and the case: see 5.10 Capacitance measurement: see 5.7 No breakdown or interruption accepted; maximum variation of capacitance: 5 %
Sealing test			See 5.14.3

Table 7 – Test group 2: climatic tests

Tests and measurements	Standard	Test	Test method and requirements
Preliminary conditioning for measurements	IEC 68-1		Duration: 3 h Standard atmospheric conditions
Initial measurements	IEC 68-1		Test conditions: see 5.2 Voltage test between the terminals: see 5.9, table 5 Voltage test between the terminals and the case: see 5.10 Capacitance measurement: see 5.7
Damp heat, steady state	IEC 68-2-3	Ca	Duration: 21 days (or 56 days, if applicable)
Final conditioning before measurements	IEC 68-1		Duration: 3 h Standard atmospheric conditions
Final measurements	IEC 68-1		Test conditions: see 5.2 Voltage test between the terminals: see 5.9, table 5 Voltage test between the terminals and the case: see 5.10 Capacitance measurement: see 5.7 No breakdown or interruption accepted; maximum variation of capacitance: 5 % Visual inspection: no trace of rust shall be visible on the surface of the capacitor case, cover and terminals

Annex A
(informative)

Informations on tests on components made of insulating material (i.e. insulators)

A.1 Ball-pressure test (IEC 309-1, sub-clause 27.3): at 125 °C or at t_c + 40 °C, whichever the higher.

A.2 Tracking resistance (IEC 309-1, sub-clause 27.5): at 175 V.

A.3 Glow-wire test (IEC 695-2-1): at 550 °C if $I_N \leq 0,5$ A;
at 850 °C if $I_N > 0,5$ A.

A.4 Reference documents

IEC 309-1: 1988, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

IEC 695-2-1/0: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 0: Glow-wire test method – General*

IEC 695-2-1/1: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 1: Glow-wire end-product test and guidance*

IEC 695-2-1/2: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 2: Glow-wire flammability test on materials*

IEC 695-2-1/3: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 3: Glow-wire ignitability test on materials*

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60068-2-21(1983) Environmental testing — Part 2: Tests — Test U: Robustness of terminations and integral mounting devices	IS 9000 (Part 19/Sec 1 to 5): 1981 Basic environmental testing procedures for electronic and electrical items: Part 19 Robustness of terminations and integral mounting devices (Sections 1 to 5 in one volume) (*first revision*)	Technically equivalent
IEC 60112 (1979) Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions	IS 2824:1975 Method for determining the comparative tracking index of solid insulating materials under moist conditions (*first revision*)	do
IEC 60335-2-25 (1993) Safety of household and similar electrical appliances — Part 2: Particular requirements for microwave ovens	IS 302-2-25 (1994) Safety of household and similar electrical appliances : Part 2 Particular requirements, Section 25 Microwave ovens	do

Only the English text of the International Standard had been retained while adopting it as an Indian Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding of numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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